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Galaxy Inclination and Surface Brightness

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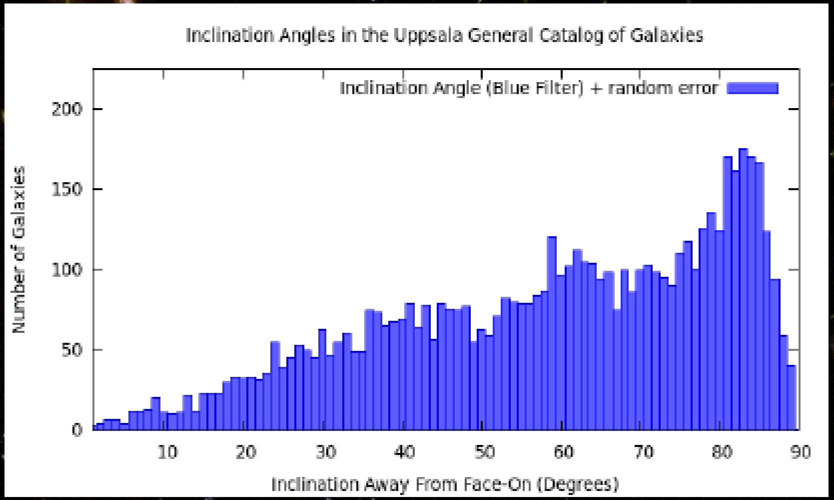
Jordan C. Rozum and Shane L. Larson - Student Showcase 04/11/2013 at USU

Galaxy Catalogs

Galaxies and their characteristics are compiled in galaxy catalogs. Using this information we can (in principle) examine how galaxies are oriented in the cosmos. We expect a random distribution (flat histogram), but we get this:



Are Galaxies Harder to See from Certain Angles?

We might be able to explain the observed inclination distribution if this is the case. This could be caused by the apparent densities of stars and dust in pixels in our cameras.

Modeling the Mass

To figure out if this idea works, we start by modeling the luminous and dusty mass in galaxies. We take theoretical density distributions and apply a transformation to rotate them. This is the first step in finding out how bright a galaxy looks from different angles.

$$\rho_{disk} = \frac{\Sigma_d}{2z_d} exp\left(-\frac{R_m}{R_d} - \frac{R}{R_d} - \frac{|z|}{z_d}\right)$$

$$\rho_{bulge} = \rho_0 \left(\frac{m}{r_0}\right)^{\gamma} \left(1 + \frac{m}{r_0}\right)^{\gamma - \beta} e^{-m^2/r_t^2}$$

$$m \equiv \sqrt{R^2 + \frac{z^2}{q^2}}$$

Converting Mass to Luminosity

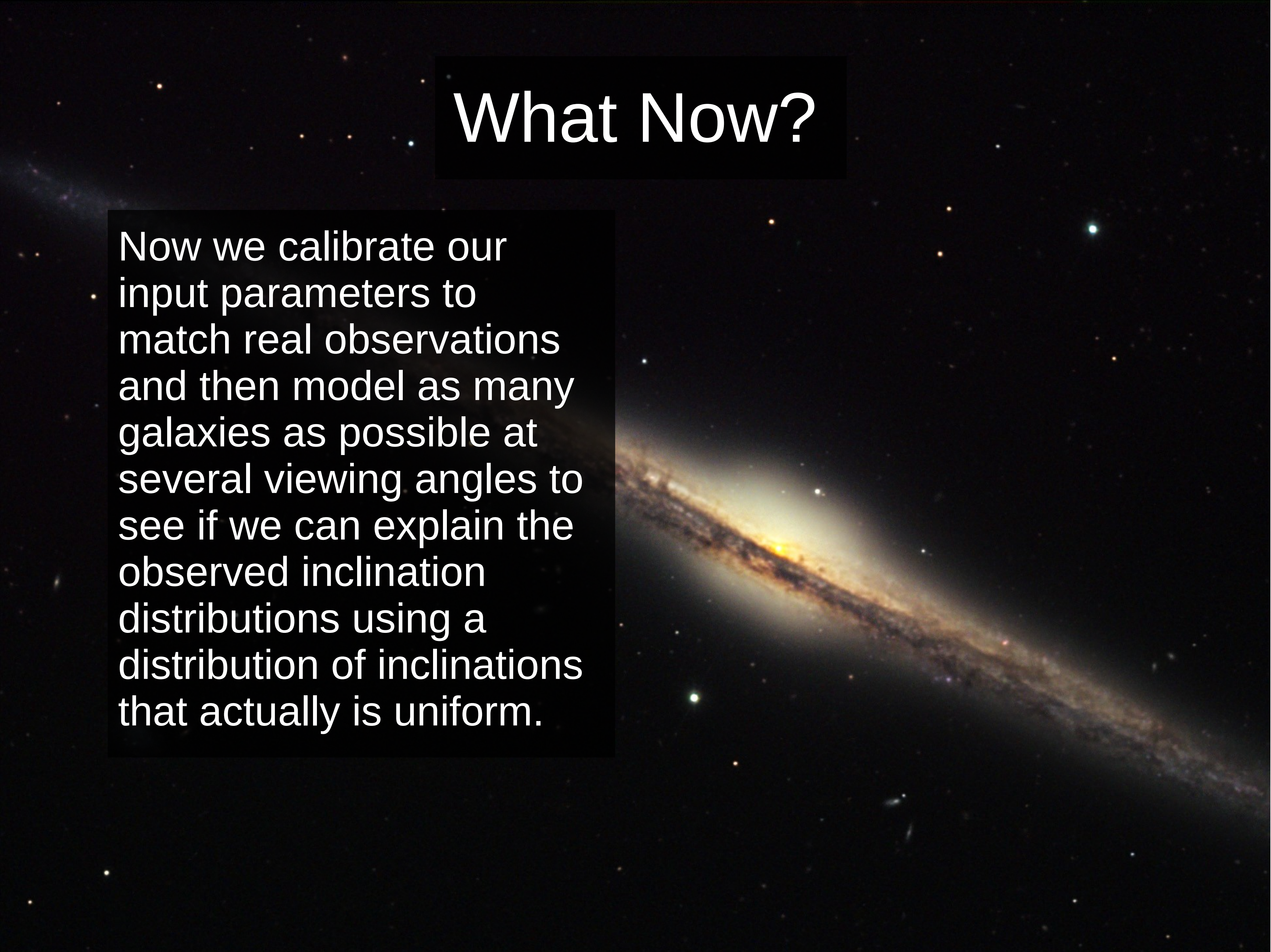
To get brightness from mass, we look at a small chunk of our model galaxy and apply an initial mass function to figure out how many stars of various masses were in it when the galaxy was young. Then, we take out any stars that would have died since then. For a star (in the main sequence) of a given mass, we know its brightness. We can add all these brightnesses together to figure out how bright our chunk is.

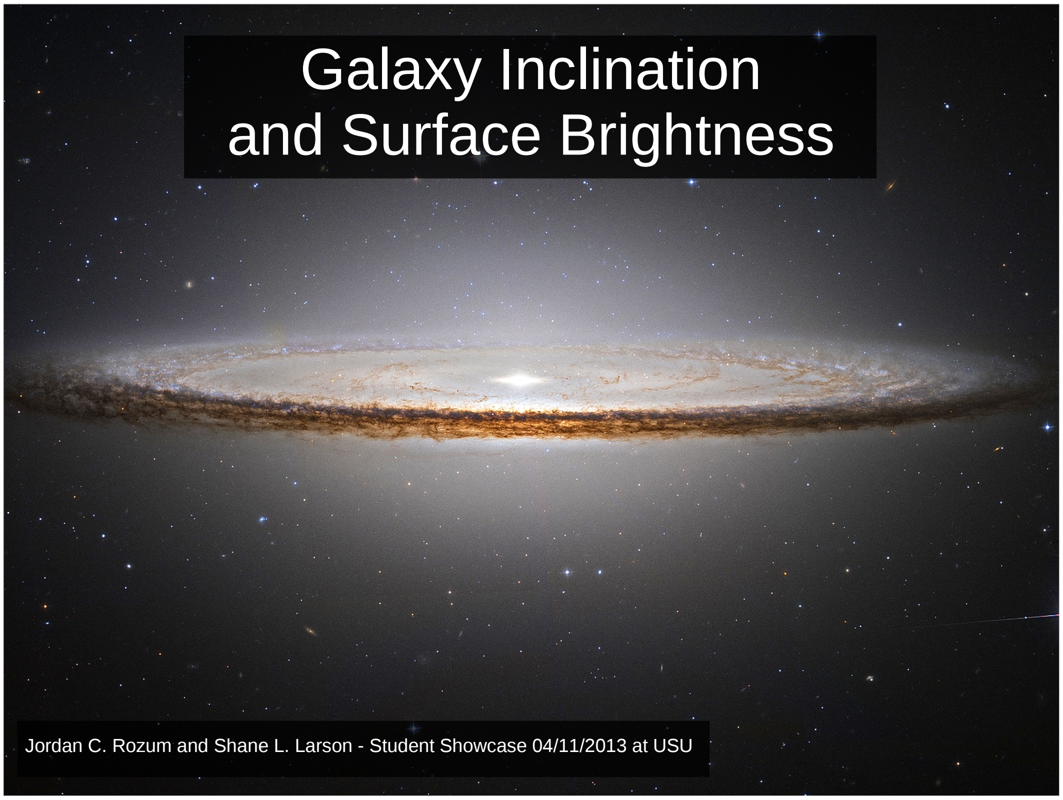
Light Extinction by Dust

Some of the light from each of our chunks gets scattered or absorbed by dust. We assume this happens in exponentially. After we reduce the brightness in this way, we add up the brightnesses of the chunks to get the surface brightness of the galaxy.

What Now?

Now we calibrate our input parameters to match real observations and then model as many galaxies as possible at several viewing angles to see if we can explain the observed inclination distributions using a distribution of inclinations that actually is uniform.





Sombrero Galaxy: M 104, UGC 293, NGC 4594

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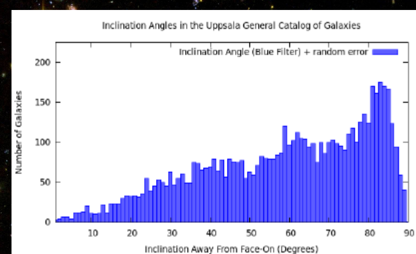
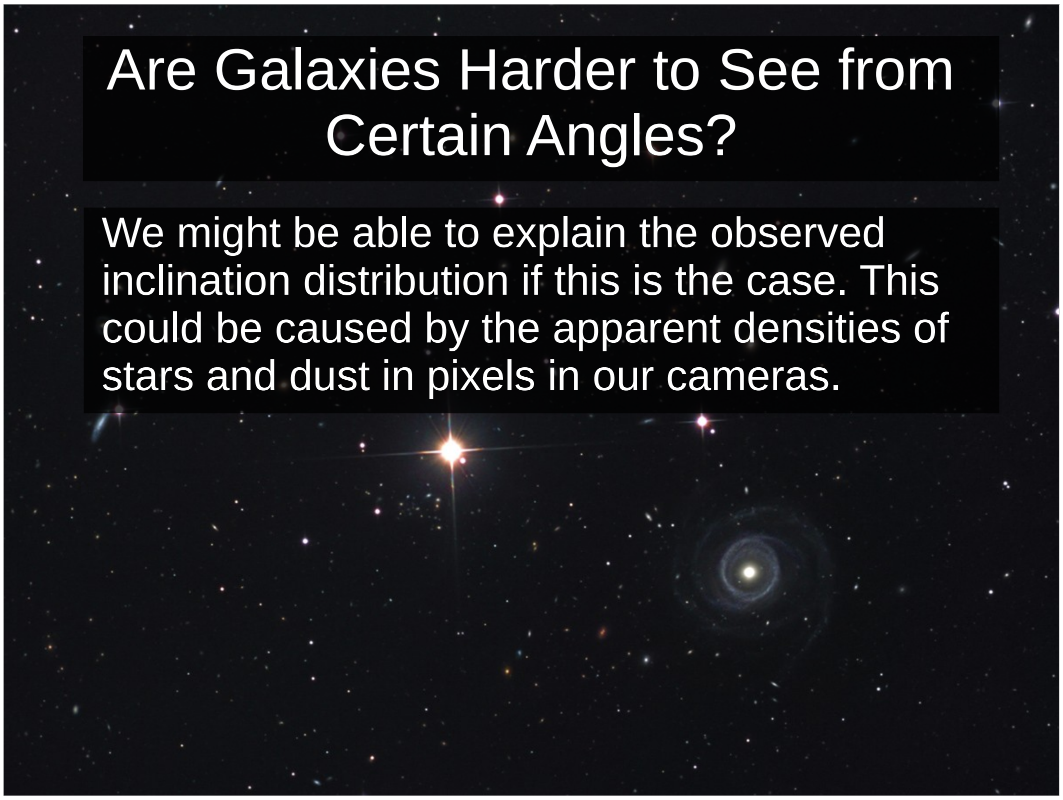


Hubble UDF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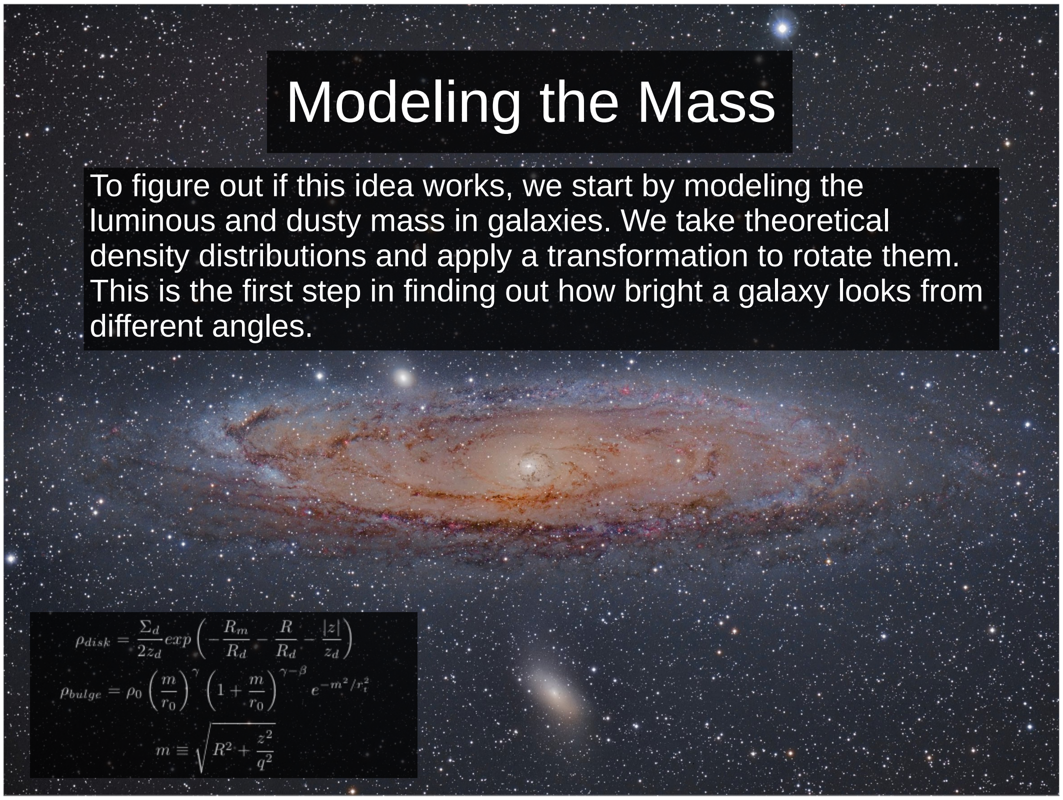
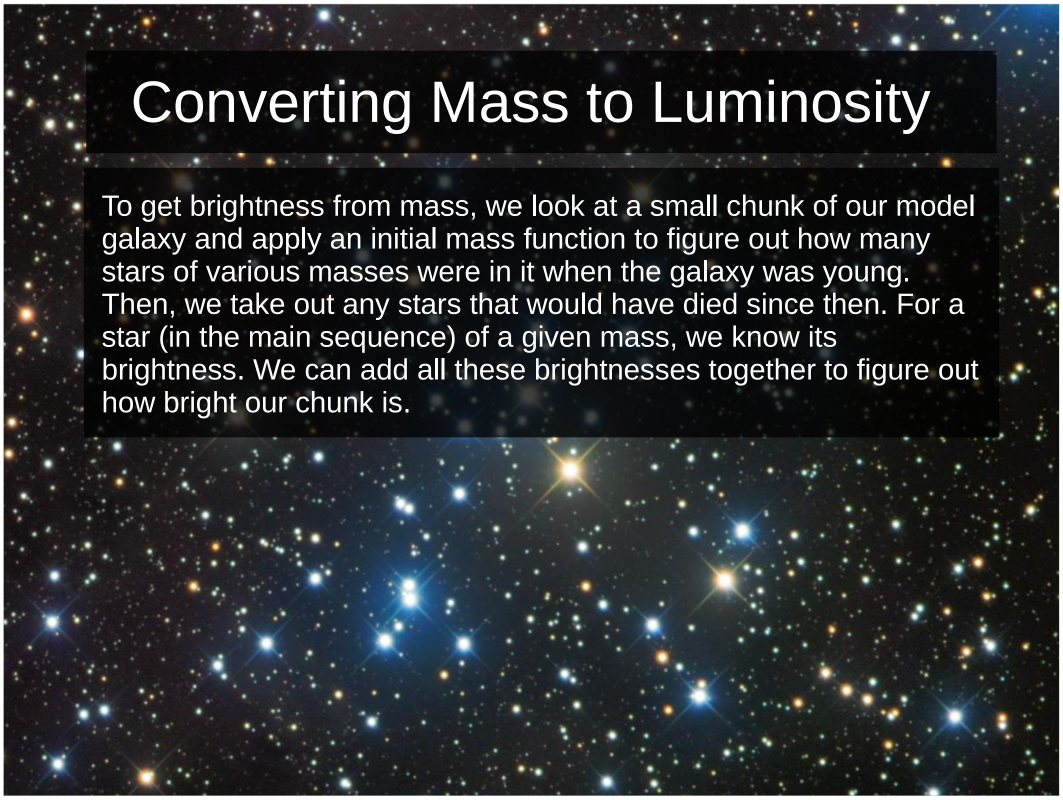
UGC 6614

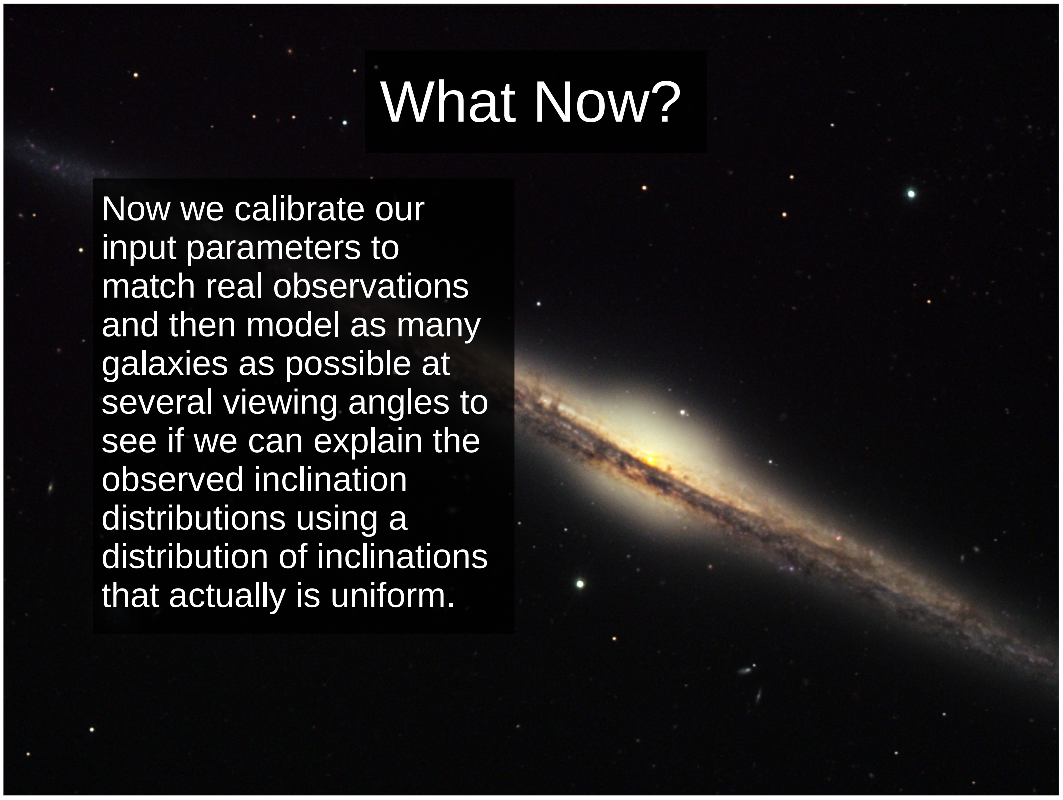


Andromeda: M31



Open Cluster M41

NGC 891, UGC 1831



Needle Galaxy: NGC 4565